PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in or relating to Inclined-dish Granulators and Classifiers

We, WILHELM EIRICH, of Bahnhofstrasse, Hardheim/Nordbaden, Germany, and GUSTAV EIRICH, of 40, Walldürnerstrasse, Hardheim/Nordbaden, Germany, both German citizens, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to inclined-dish granulators and classifiers, and more particularly to granulating and classifying devices of the kind having an inclined or inclinable dish rotating about its centerline. The invention also relates to associated methods of classification.

For continuous operation of inclined-dish granulators and classifiers, it is important that the separation between fines and the granules which have been formed by agglomeration of material in the dish should take place in the lower zone of the dish in such manner that the coarsest granules will overflow the rim. Only if the bottom of the dish is steeply pitched will the point where the largest granules separate, i.e. the so-called coarse zone, be located close to the rim, so as to ensure proper discharge of the large, finished granules. Such a steep setting, however, results in a comparatively small capacity in a granulating or classifying dish of given size, with consequently small rate of output. Contrary thereto, as the setting of the dish becomes flatter, its capacity increases rapidly. Thus, for example, a granulating or classifying dish which is 2200 mm. in diameter and 1100 mm. in depth and which has its bottom set at an inclination of 60—63° to the horizontal will have a capacity of roughly 1200 kg. if the specific gravity of the material being granulated or classified is about 1.09; whereas upon reduction of the dish bottom inclination to about 50°, the dish would hold as much as about 2400 kg.

However, with flatter settings, the zone of separation of coarse grains shifts radially inward and is located at a distance from the associated rim. Consequently, with flatter settings the coarse grains are not regularly discharged and undesirable oversize grain results. The proportion and size of this grain increase fairly rapidly and the dish delivers reject material. With such a flatter setting, therefore, constant manual attention becomes necessary, the oversize grain being smashed with a shovel, or picked out of the dish with a fork and smashed or crushed outside the dish. Alternatively, an attendant must divert the coarse fraction by setting the dish bottom at a steeper angle or reducing the speed, and get the dish back to providing a normal grain size. Such attention and control is, however, difficult and, especially the three-shift operation such as prevails for example in the cement industry, occasions considerable extra cost.

In known dish granulators and classifiers, to ensure discharge of the finished granules by overflow, the dish must of course always be kept filled to its brim. Consequently the dish cannot be stopped without change of inclination if more material is not to overflow, because when the dish stops, the material in the dish will no longer be drawn upward, and material will accumulate in the bottom of the dish, involving continued overflow. This too interferes with the control and operation of known dish granulators and classifiers.

Now it has previously been proposed that the trouble caused by oversize granules be eliminated by means of a bar or strip agitator revolving circularly or elliptically counter to

the direction of rotation of the granulator or classifier and dipping into or raking over the material to be granulated or classified, while not touching or scraping the bottom of the dish. This agitator is intended to break down any oversize granules formed. But such a comminution means must necessarily function at sufficiently high rotational speed for the oversize grains to be actually broken down and this in turn implies that the agitator will also break down some normal grain, and to that extent reduce the output of the granulator or classifier. Also, the crushing of oversize grains or granules yields irregularly shaped fragments, departing from the desired approximately spherical form. Depending on the kind of material being processed, there may also be the danger that the coarse-grained fraction not discharged may grow so rapidly that the comminutor cannot keep up, and the dish will perform improperly anyway.

An object of the invention is to provide an improved inclined-dish granulator or classifier.

According to the invention there is provided a granulator or classifier including a rotatable dish and discharge means within said dish, said discharge means including a toothed rotatable rake and means for driving said rake, the latter being disposed so as to impel from the dish particles of material of greater than a maximum predetermined size. To ensure that the rake can always be located in the so-called coarse zone, where the largest granules separate, it is preferred that the rake be made adjustable in vertical position relative to a basal wall of the dish, in radial distance from the axis of rotation of the dish, and also in a direction circumferential of the dish.

The rake employed as discharge means according to the invention projects the granules over the rim of the dish by centrifugal force. In order that this ejection may always be adjustable as desired, it is preferred that the position of the axis of rotation of the rake relative to the dish be made adjustable as well. By detachable and interchangeable connection of each row of teeth to the shaft driving it, and by the other features of adjustability as aforementioned, these handling rakes can be adapted precisely to prevailing operating conditions. Further, the rake also has some sorting action, because it throws smaller, lighter granules less far from the dish than larger, heavier granules.

According to another aspect of the invention, the tooth spacing can be made substantially equal to the desired granule size as a result of which the rake will eject granules of the desired size from the dish substantially exclusively. This both prevents the formation of oversize granules and the discharge of granules from the dish that have not yet attained the desired size.

An especially dependable operation of such a handling means is afforded if the rake has a plurality of rows of teeth, uniformly staggered in circumferential direction relative to the axis of rotation of the rake. These teeth may advantageously be of elastic material such as, for example, comparatively thin steel wire, with or without a plastic-like coating of repellant material such as, for example, Teflon (Trade Mark), rubber, or a suitably elastic plastic. They are therefore elastically flexed upon entering the material in circumferential direction and are thus freed or kept free from incrustations.

If such elastic deformation should be insufficient in certain cases to keep the teeth clear of incrustations, then a stationary stop rail may be provided for the teeth, compelling them to be elastically deformed in circumferential direction relative to the axis of rotation of the rake as they go by. To avoid resulting concussive loads on the motor driving the rake, this stop rail may be arranged obliquely to the axis of rotation of the rake in such manner that the teeth of each row will strike the rail successively.

Whereas an inclined-dish granulator or classifier may optionally be used simply as a mixer (see our prior Patent No. 859460), for which purpose it must of course be equipped with suitable mixing tools, means are preferably provided to reverse the direction of rotation of the rake drive, and preferably also to vary the speed of such drive. The handling means according to the invention, which means will not in that event function as such, will then promote the mixing process, interfering with separation of any coarse fraction, if one is present, and permitting maintenance of a well-defined period of residence of the material in the dish. In mixing likewise, then, the equipment may be operated continuously and intermittently, as desired. In intermittent mixing operations, the discharge will be effected either by setting the basal wall of the dish vertical, or by means of a withdrawal and closure device of known type, installed in the centre of the dish. The inclined position of the dish during mixing affords the further advantage that the dish can be filled quite deep and nevertheless operate at comparatively low power consumption because, in the area where the mixing tools act, the portion uppermost because of the inclination of the dish, the depth of the bed of material is less than in the lower part of the dish. As a further result, the entire contents of the dish are being turned over at all times, even in that part of the dish where the mixing tools do not reach.

An embodiment of the invention is represented by way of example in the drawing, in which:

Fig. 1 is a side view of an inclined-dish

granulator according to the invention, viewed in the direction of the arrow I in Fig. 2;

Fig. 2 is a front view of the same granulator in the direction of the arrow II in Fig. 1; and

Fig. 3 is a top view of the same inclined-dish granulator.

The inclined dish consists of a basal wall 1 and side wall 2. It may be provided with a stationary cover 3 extending, as appears in Figs. 2 and 3, over a circumferential angle of about 270° and exposing only the area occupied by a discharge means to be later described.

The dish may be swung, for example, by means of a hydraulic cylinder 4 about a pivot 5, so that it may be brought to any desired inclined position. Possible operating positions range, for example, from 45 to 60°, but for dumping purposes the dish can be swung all the way to 90°.

The dish is rotated on its axis of rotation which is coincident with the axis of symmetry of wall 2, by two motor gear reducers 6 and 7. In the part of the inclined dish which is uppermost because of its inclined position and which is remote from a rake to be described hereinunder, there are mixing means, for example, in the form of powered rotating mixer blades driven by an electric motor 8. This electric motor and the mixing means are borne by an arm 9 mounted on the chassis C rotatable together with the dish about the shaft 5. Arm 9 supports the stationary cover 3 and also a stationary pin 10 in line with the centerline or axis of rotation of the inclined dish.

Pin 10 is fitted with a vertically and circumferentially adjustable sleeve 11 bearing a radially extending arm 12. On this arm 12 is arranged an additional sleeve 13, radially displaceable along and rotatable about the arm 12, and capable of being fixed in any desired setting. This sleeve 13 bears the motor 14 and reduction gear 15 driving the shaft 16*a* of a rake 16 which, in the embodiment shown by way of example, has four rows of teeth T of an elastic material such as, for example, steel wire. The shaft 16*a* preferably has an axis of rotation which is perpendicular to the axis of rotation of the dish so that the shaft is parallel to the basal wall 1. By appropriate setting of its position radially, circumferentially, vertically, and in the relation of its axis of rotation to the basal wall 1, rake 16 is so adjusted as to be located in the zone where the largest granules emerge at the surface of the contents of the dish, and so that it can propel these largest granules (i.e., granules of greater than a predetermined size) over the rim of the dish wall 2 out of the dish, the teeth T being appropriately spaced in each row for this purpose. The teeth T of the rake 16 are given a movement (due in the illustrated case to simple rotation of shaft 16*a*) having a vector which is parallel to the axis of rotation of the dish so that said granules are propelled out of the dish.

In the vicinity of the ejection zone of rake 16, a hopper 17 may be provided, operatively disposed relative to a conveyor system 18, indicated schematically, employed to carry off the finished granules.

The inclined dish is supplied, in the embodiments shown by way of example, through a chute 19 passing through an opening in the cover 3. As Fig. 1 shows, a bellows 20 may be provided for dustproof connection of the chute 19 to the cover 3. In order to permit removal of the chute 19 from the dish when the dish is to be swung to its maximum inclination, for example 90°, the chute 19 is pivotably suspended from a shaft 21. To permit rapid escape of air when the dish is being filled, a vent connection 22 may be provided in the cover 3.

The teeth T of the rake 16 are so proportioned in length and diameter that their dipping action will set them in vibration in the manner of a tuning fork. In this way, any materials tending to incrustation will be detached from the teeth of the rake. If this effect should not suffice to clean the teeth in special cases, a special stationary stop rail R may be provided for the teeth whereby the teeth will be elastically deformed and set in vibration. Such a stop rail may expediently be arranged obliquely to the rake centerline so that the teeth of any row will strike the rail successively. This will avoid concussive loads on the motor 14 driving the rake 16. In addition, spraying nozzles are provided on the stop rail R and connected to a liquid supply (not shown) for assisting agglomeration of material in the dish.

The rake motor 14 should preferably be reversible so that it can serve as a comminutor whenever the inclined dish granulator is to be used as a mixer, with the basal wall 1 more or less horizontal. To adapt the operation of rake 16 to different operating conditions, in particular materials and desired sizes of granules, means may be provided to adjust the drive speed of rake 16, consisting of, for example, a control for the rake motor 14 or a variable-speed transmission in the gear train 15.

From what has been stated above, it will be appreciated that the invention also relates to a method which comprises centrifuging a granular material in a dish having an inclined axis of rotation to bring the coarser grains to the periphery of the dish and to the top of the material therein, the method also comprising raking through the material at the top thereof and at a predetermined distance from said periphery to propel the coarser grains from the dish.

It will be appreciated from the description

of the apparatus hereinabove that the size of the grains propelled from the dish may be adjusted by adjusting the speed of raking and also by adjusting the position of raking.

In any event, the raking will be effected in such a manner as to have a force vector which is parallel to the axis of rotation of the dish, or in other words, which is such as to propel the desired grains through the stationary cover of the apparatus and the opening provided therein.

It will be understood that although the complete apparatus acts as a granulator, the rake itself does not produce granules (when rotated in its main direction) but simply separates out the larger granules, that is to say, it exercises a classifying action.

It has been found that the formation of oversize grain can be dependably avoided in the described granulator and it has been possible to employ substantially flatter dish adjustments, and hence fuller loading and consequently a higher output rate, without necessitating constant observation by a trained operator. The fuller charge in turn results in greater pressure on the material, and hence increased density and strength of the granules. Consequently, granules of adequate strength can be produced in many applications without the addition of moisture, thus rendering subsequent drying superfluous in some cases. The operational advantages of lower moisture content in the granules produced require no explanation. Operating with fuller charge has the additional advantage that any mixing tools provided in the dish, notably in the portion uppermost because of the inclined position, become substantially more effective because of their greater depth of immersion. Such tools will moreover accelerate the rolling action of the mass, thus mixing and consolidating it more intensively.

It has also been found that the described granulator need not operate in an overflow setting, since the discharge of finished granules is accomplished by the handling means. Thus the dish need not be kept filled to overflowing as formerly was the case, but may be so set that the level of material being granulated is lower than the rim of the dish at the point of exit. Thus it has been possible to stop the feed without stopping the dish and also to do so without altering the inclination of the basal wall of the dish. In fact such an interruption has been very simply accomplished by briefly stopping the handling system. Thus it has been possible, without interruption of the mixing and granulating operation in a dish, to convey the granules to a weighing receptacle, conveyor truck, bucket elevator or the like and the brief interruption to discharge has been affected by fully automatic control via a weighing or conveying device. Batchwise, automatically controlled withdrawal of finished granules is very important when discontinuously operated equipment is to be kept supplied such as, for example, when filling molds with granulated pressing compound, feeding intermittently operating drying and firing systems, and so forth. The same applies to the discontinuous addition of certain processing gases or liquids to the granulated material.

Since an inclined-dish granulator embodying the invention is not dependent on overflow discharge, but may instead be operated with the surface of the material in the lowest part of the inclined dish somewhat below the rim of the dish, the supply to the granulator need not be interrupted when the discharge is interrupted, all of which of course greatly simplifies the overall control of the feeding system and its design. Again, if overflow is not to be used, the feed to the dish may in any case be intermittent, for which purpose a single- or multi-component balance can be used and fully continuous input dispensed with. As is known, batch-wise feed will afford a considerably higher precision of proportioning, and the fully automatic devices required for this are considerably simpler and cheaper than continuously operating conveyor belt scales or the like. The entire system may be controlled by very simple means in such manner that the conveyor system is not restarted simultaneously with the termination of raw material input, but after a certain delay so that, before discharge recommences, a thorough distribution and mingling of the material introduced will first be assured.

In this intermittent procedure, contrary to other intermittently operating machinery, the batchwise input and withdrawal does not involve any loss of time or energy since the machine keeps on running without interruption, the discharge being merely arrested briefly in order to adapt the operation of the granulator to the operating conditions prevailing at the time.

WHAT WE CLAIM IS:—

1. A granulator or classifier including a rotatable dish and discharge means within said dish, said discharge means including a toothed rotatable rake and means for driving said rake, the latter being disposed so as to impel from the dish particles of material of greater than a maximum predetermined size.

2. A granulator or classifier according to claim 1, wherein the rotatable rake is adjustable in position towards or away from a basal wall of the dish.

3. A granulator or classifier according to either one of the preceding claims, wherein the rotatable rake is adjustable in position radially of the dish.

4. A granulator or classifier according to any one of the preceding claims, wherein the rotatable rake is adjustable in position in a direction circumferential of the dish.

5. A granulator or classifier according to any one of the preceding claims, wherein the axis about which the rake is rotatable lies in a plane which is substantially perpendicular to the axis of rotation of the dish.

6. A granulator or classifier according to claim 5, wherein the rotatable rake is so mounted that its axis of rotation can be adjustably inclined to a plane perpendicular to the axis of rotation of the dish.

7. A granulator or classifier according to any one of the preceding claims, wherein the spacings between adjacent teeth of the rake are substantially equal to the desired granule size.

8. A granulator or classifier according to any one of the preceding claims, wherein the rotatable rake is provided with a plurality of rows of teeth.

9. A granulator or classifier according to any one of the preceding claims, wherein the teeth of the rotatable rake are sufficiently resilient as to vibrate during operation of the granulator so as to detach therefrom any materials tending to incrustation.

10. A granulator or classifier according to claim 9, wherein the teeth of the rotatable rake are formed of steel wire.

11. A granulator or classifier according to claim 10, wherein the teeth of the rotatable rake are coated with a synthetic plastic material.

12. A granulator or classifier according to any one of claims 9—11, wherein a stationary rail is provided against which the teeth of the rotatable rake strike as said rake rotates, whereby said teeth are caused to vibrate.

13. A granulator or classifier according to claim 12, wherein the stationary rail is or can be disposed obliquely to the rake axis of rotation so that the teeth of the rake strike said rail successively.

14. A granulator or classifier according to any one of the preceding claims, including means for tilting the dish about a horizontal axis.

15. A granulator or classifier according to any one of the preceding claims, wherein the dish is provided with a stationary cover, said cover having an opening through which material contained in said dish can be discharged.

16. A granulator or classifier according to claim 15, wherein means are pivotally disposed to supply material to the dish.

17. A granulator or classifier according to either one of claims 15 and 16, wherein a pin supported by an arm mounted on a chassis supports one end of a further arm at the other end of which are mounted the rotatable rake and the means for driving said rake.

18. A granulator or classifier according to claim 17, wherein the means for driving the rotatable rake include an electric motor and reduction gear.

19. A granulator or classifier according to claim 18, wherein means are provided for reversing the direction of rotation of the rotatable rake whereby the granulator or classifier may be used as a mixer.

20. A granulator or classifier according to either one of claims 18 and 19, wherein means are provided for adjusting the speed of rotation of the rotatable rake.

21. A method of classifying material in which the material is centrifuged in a dish having an inclined axis of rotation to bring the coarser grains to the periphery of the dish and to the top of the material therein, and raking through the material at the top thereof and at a predetermined distance from said periphery to propel said coarser grains from the dish.

22. A method as claimed in claim 21 comprising adjusting the size of the grains propelled from the dish by adjusting the speed of raking.

23. A method as claimed in claim 21 comprising adjusting the size of the grains propelled from the dish by adjusting the position of raking.

24. A method as claimed in claim 21 comprising directing the raking to have a vector parallel to said axis.

25. A granulator or classifier constructed, arranged and adapted to operate substantially as hereinbefore described with reference to and as illustrated by the accompanying drawings.

26. A method of granulating or classifying material as hereinbefore described with reference to and as illustrated by the accompanying drawings.

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1072328 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

Fig.1

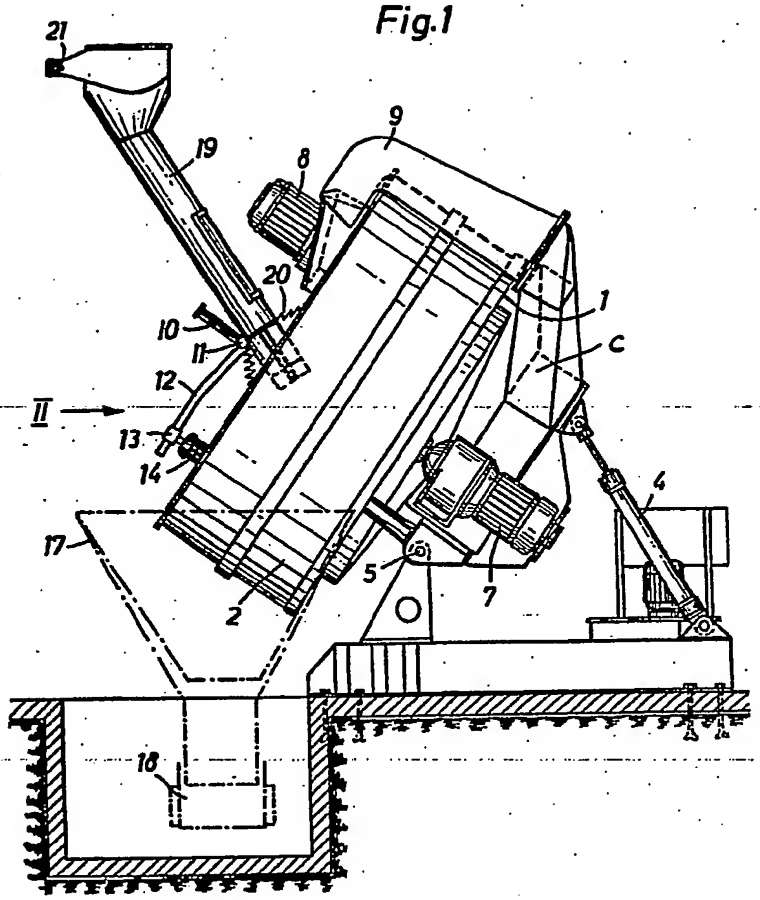
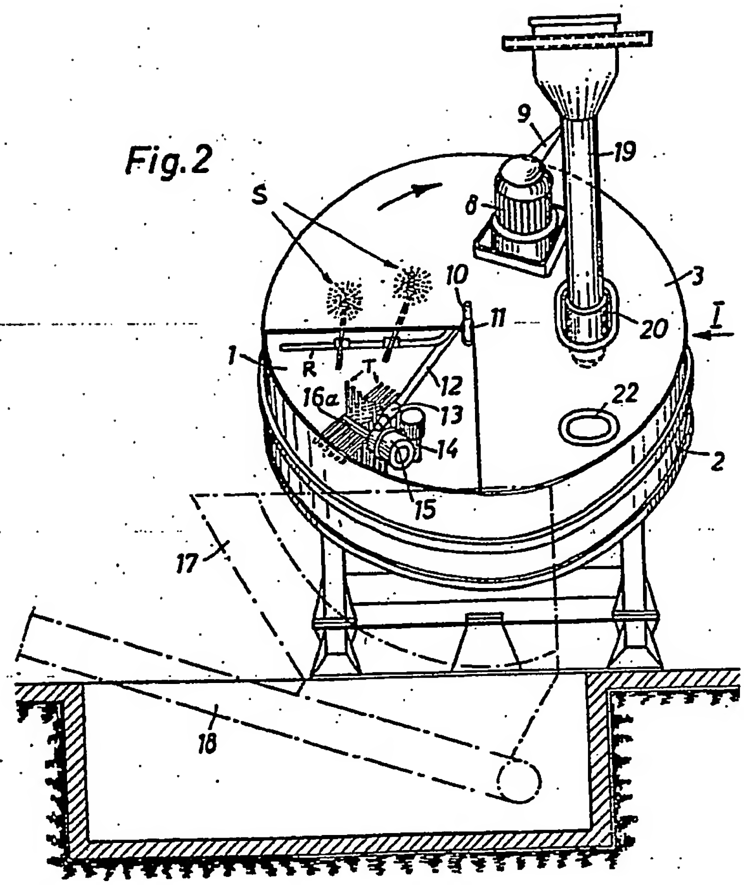


Fig. 2



1072328 COMPLETE SPECIFICATION
3 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 2 & 3

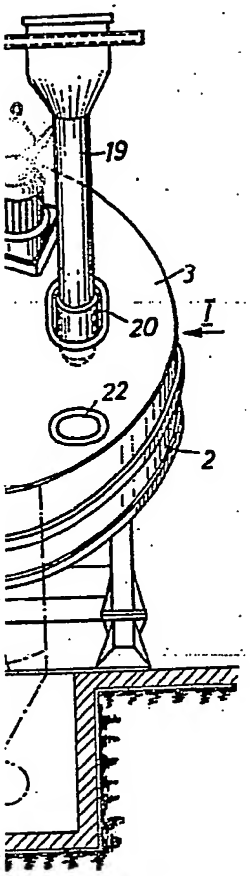
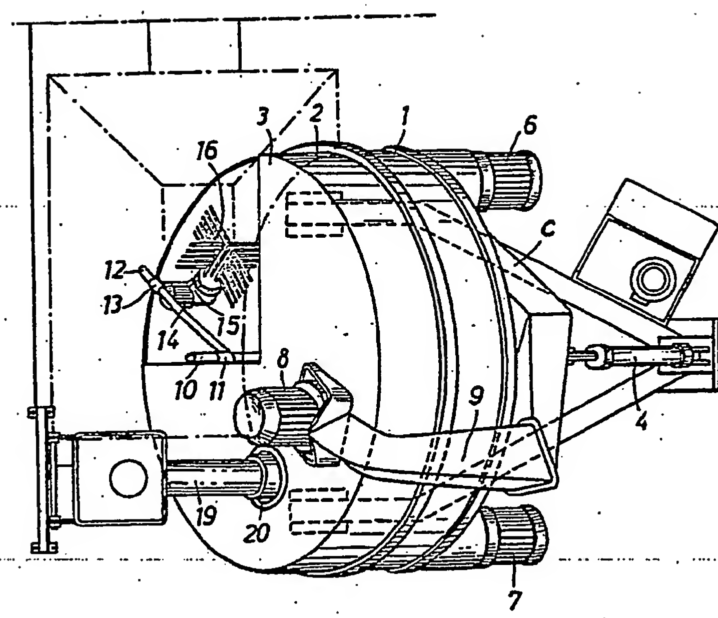


Fig. 3



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3 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 2 & 3

Fig. 2

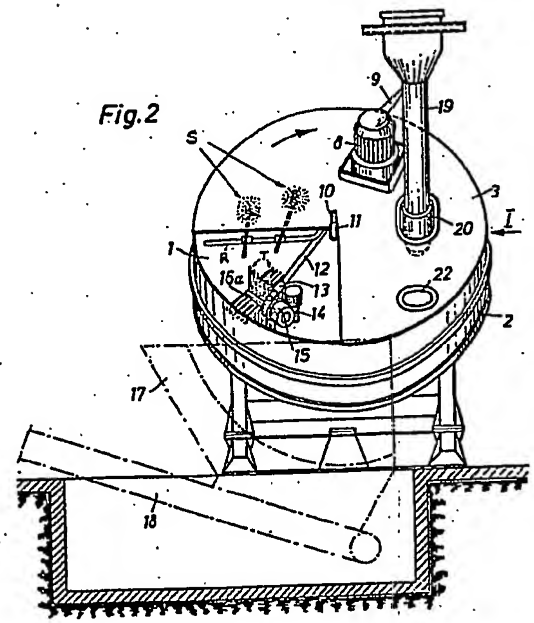

Fig. 3